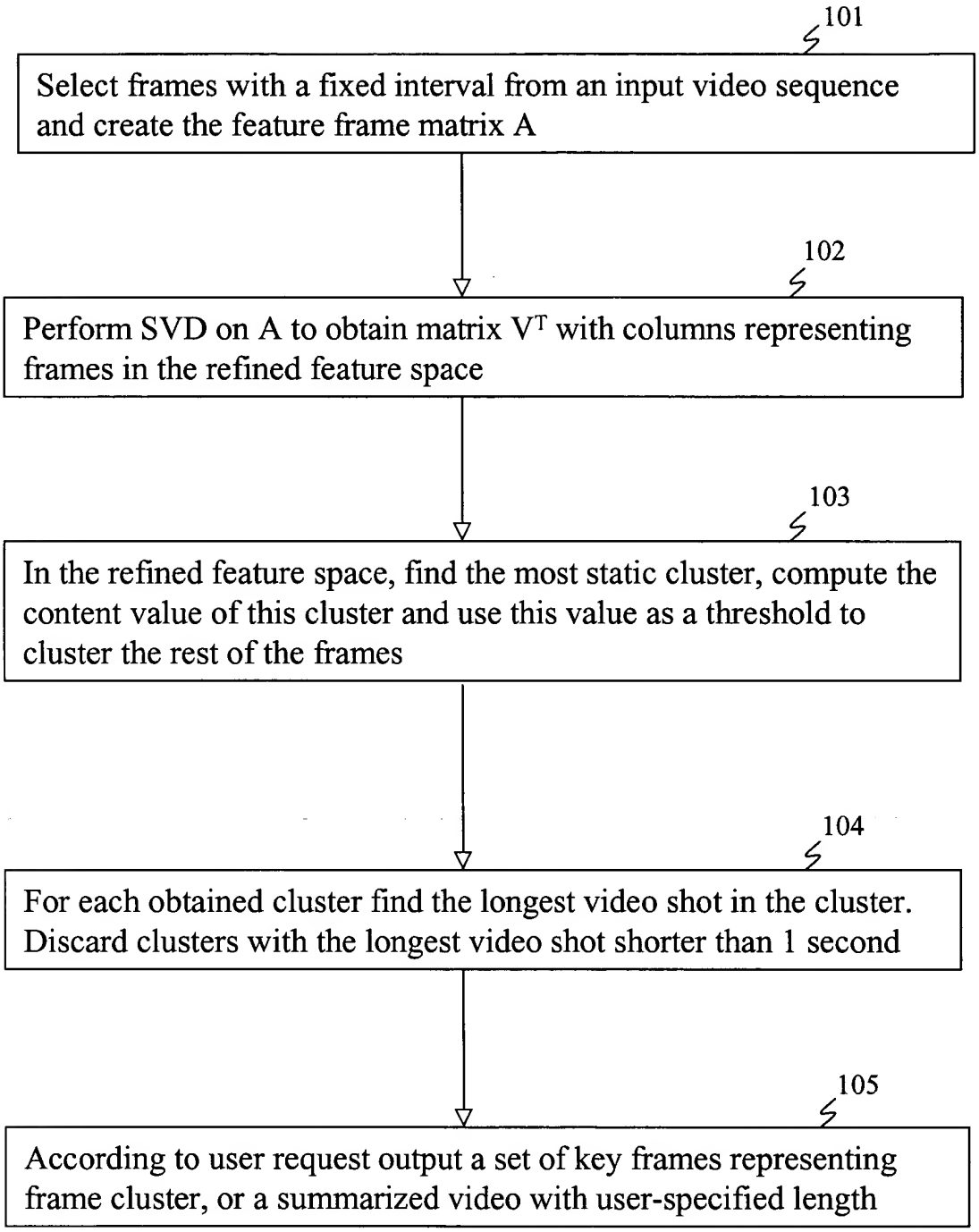

101
Select frames with a fixed interval from an input video sequence and create the feature frame matrix A
102
Perform SVD on A to obtain matrix V^T with columns representing frames in the refined feature space
103
In the refined feature space, find the most static cluster, compute the content value of this cluster and use this value as a threshold to cluster the rest of the frames
104
For each obtained cluster find the longest video shot in the cluster. Discard clusters with the longest video shot shorter than 1 second
105
According to user request output a set of key frames representing frame cluster, or a summarized video with user-specified length

FIG. 1

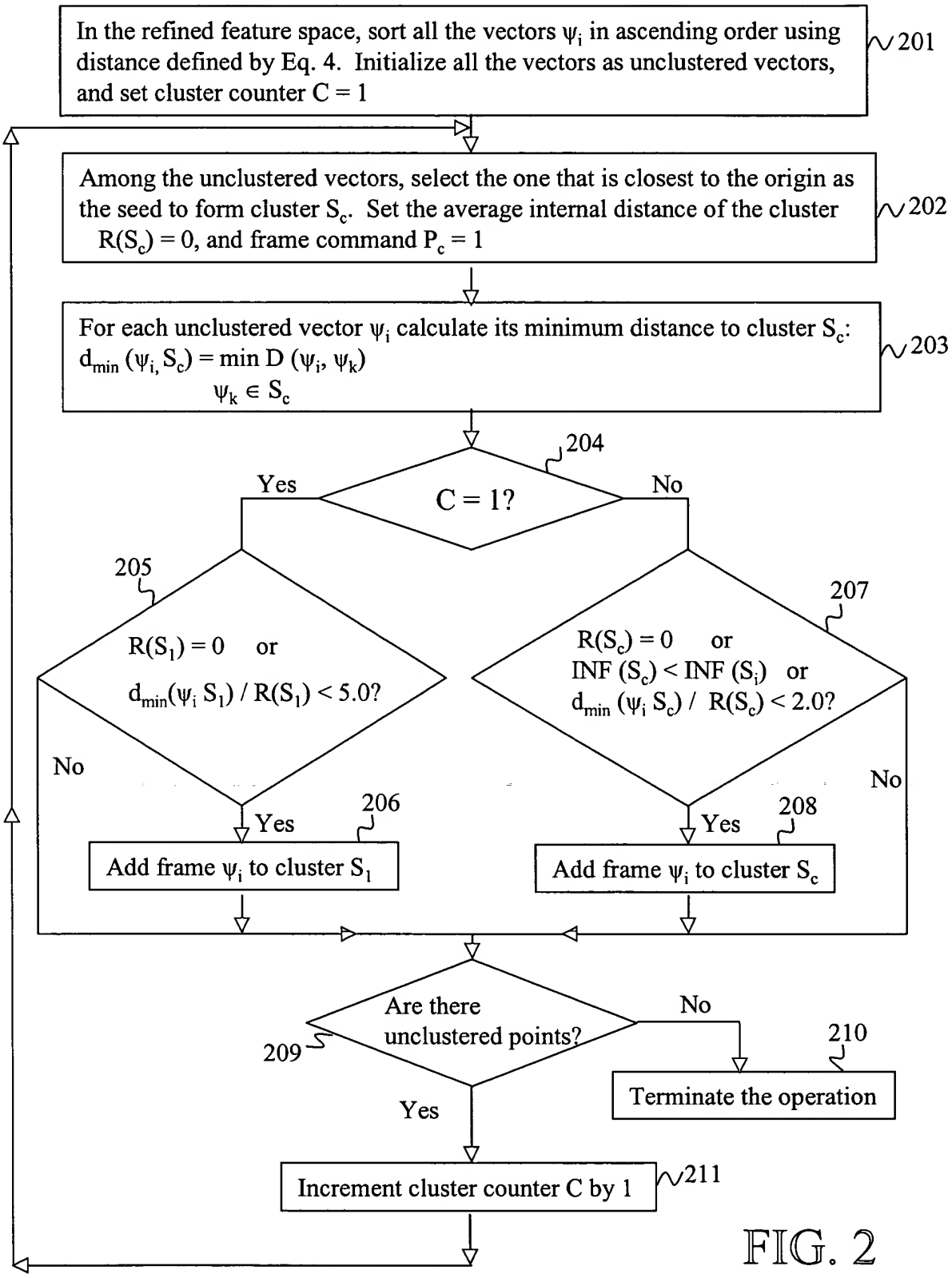

In the refined feature space, sort all the vectors ψ_i in ascending order using distance defined by Eq. 4. Initialize all the vectors as unclustered vectors, and set cluster counter C = 1
201
Among the unclustered vectors, select the one that is closest to the origin as the seed to form cluster S_c. Set the average internal distance of the cluster $R(S_c) = 0$, and frame command $P_c = 1$
202
For each unclustered vector ψ_i calculate its minimum distance to cluster S_c: $d_{min}(\psi_i, S_c) = \min D(\psi_i, \psi_k)$ $\psi_k \in S_c$
203
204
C = 1?
Yes
No
205
$R(S_1) = 0$ or $d_{min}(\psi_i S_1) / R(S_1) < 5.0$?
No
Yes
206
Add frame ψ_i to cluster S_1
207
$R(S_c) = 0$ or INF (S_c) < INF (S_i) or $d_{min}(\psi_i S_c) / R(S_c) < 2.0$?
No
Yes
208
Add frame ψ_i to cluster S_c
Are there unclustered points?
209
No
210
Terminate the operation
Yes
Increment cluster counter C by 1
211

FIG. 2

FIG. 3

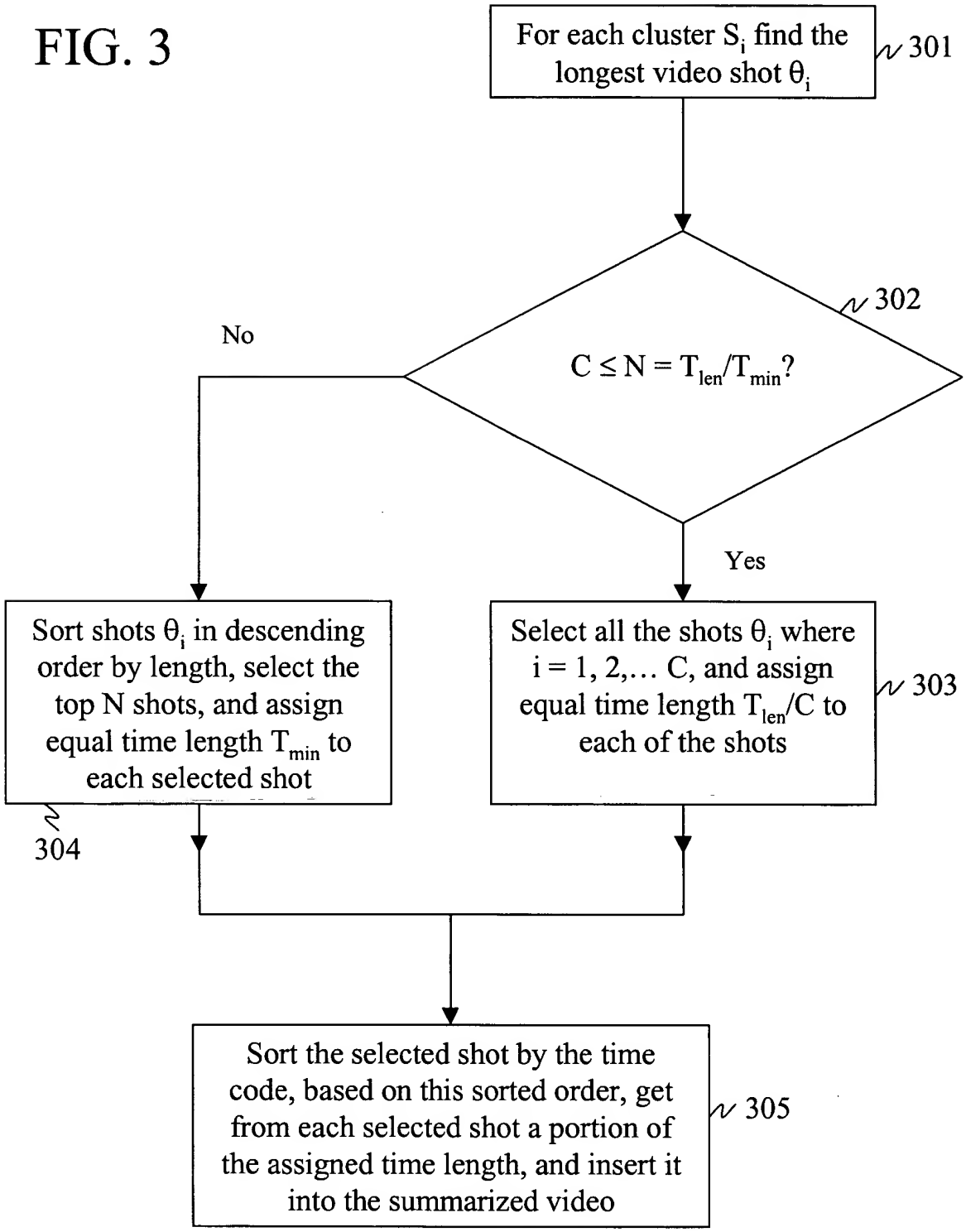

For each cluster S_i find the longest video shot θ_i
301
302
$C \leq N = T_{len}/T_{min}$?
No
Yes
Sort shots θ_i in descending order by length, select the top N shots, and assign equal time length T_{min} to each selected shot
304
Select all the shots θ_i where i = 1, 2,... C, and assign equal time length T_{len}/C to each of the shots
303
Sort the selected shot by the time code, based on this sorted order, get from each selected shot a portion of the assigned time length, and insert it into the summarized video
305

FIG. 4

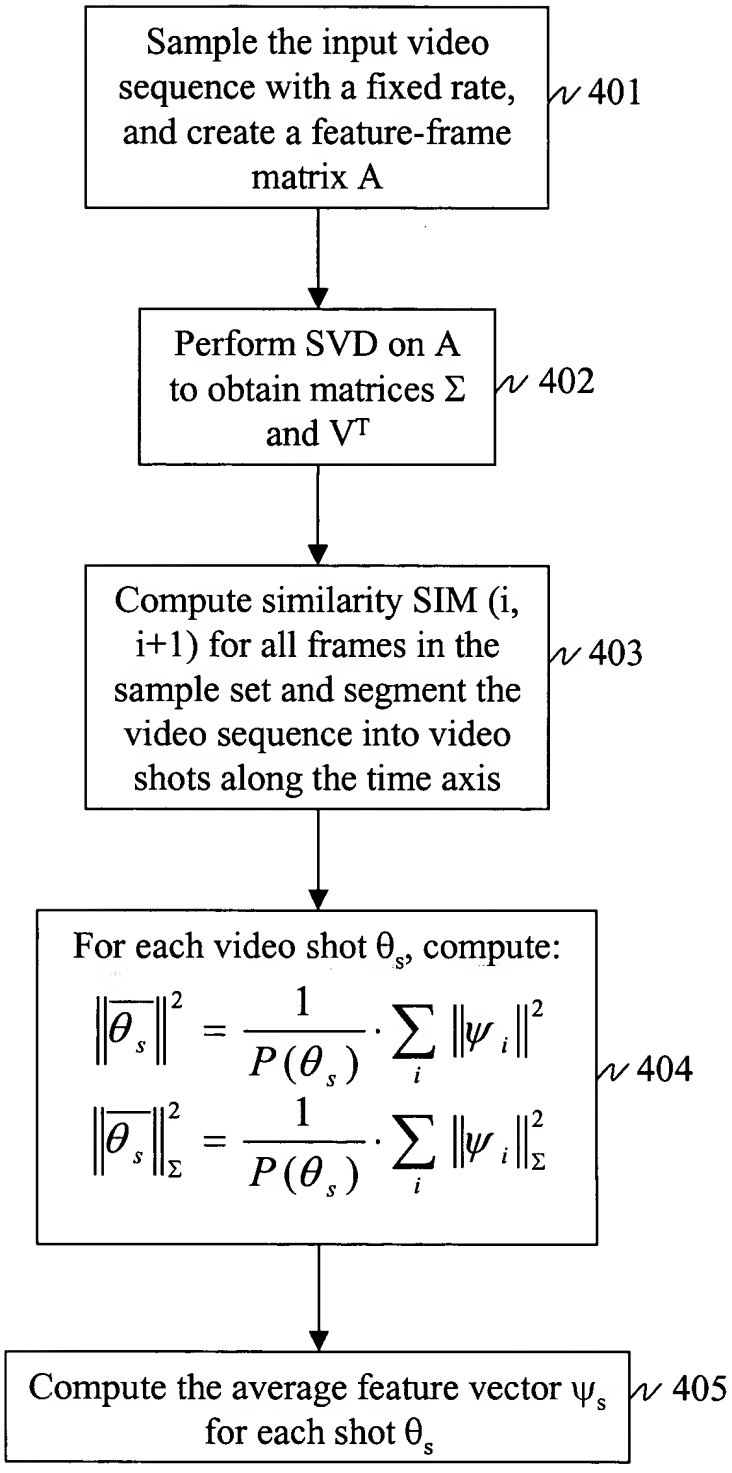
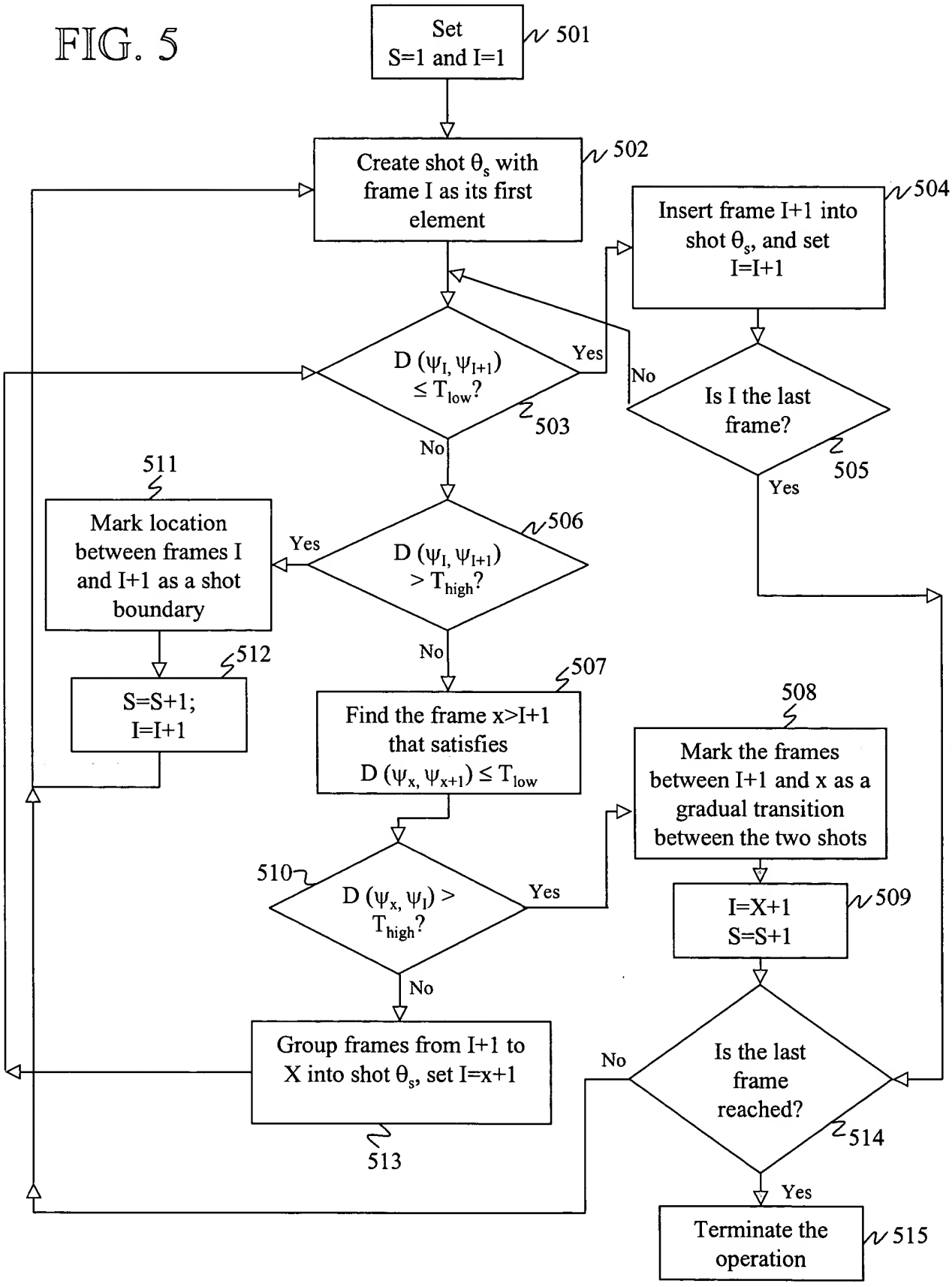

Sample the input video sequence with a fixed rate, and create a feature-frame matrix A
401
Perform SVD on A to obtain matrices Σ and V^T
402
Compute similarity SIM (i, i+1) for all frames in the sample set and segment the video sequence into video shots along the time axis
403
For each video shot θ_s, compute:
$\|\overline{\theta_s}\|^2 = \frac{1}{P(\theta_s)} \cdot \sum_i \|\psi_i\|^2$
$\|\overline{\theta_s}\|_\Sigma^2 = \frac{1}{P(\theta_s)} \cdot \sum_i \|\psi_i\|_\Sigma^2$
404
Compute the average feature vector ψ_s for each shot θ_s
405

FIG. 5


Set S=1 and I=1
501
Create shot θ_s with frame I as its first element
502
Insert frame I+1 into shot θ_s, and set I=I+1
504
$D(\psi_I, \psi_{I+1}) \leq T_{low}$?
503
Yes
No
Is I the last frame?
505
Yes
No
Mark location between frames I and I+1 as a shot boundary
511
$D(\psi_I, \psi_{I+1}) > T_{high}$?
506
Yes
No
S=S+1; I=I+1
512
Find the frame x>I+1 that satisfies $D(\psi_x, \psi_{x+1}) \leq T_{low}$
507
Mark the frames between I+1 and x as a gradual transition between the two shots
508
$D(\psi_x, \psi_I) > T_{high}$?
510
Yes
No
I=X+1 S=S+1
509
Group frames from I+1 to X into shot θ_s, set I=x+1
513
Is the last frame reached?
514
No
Yes
Terminate the operation
515